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(71) Applicant: **Dainippon Screen Mfg. Co., Ltd.**
1-1, Tenjinkitamachi Teranouchi-agaru
4-chome Horikawa-dori
Kamikyo-ku Kyoto 602(JP)

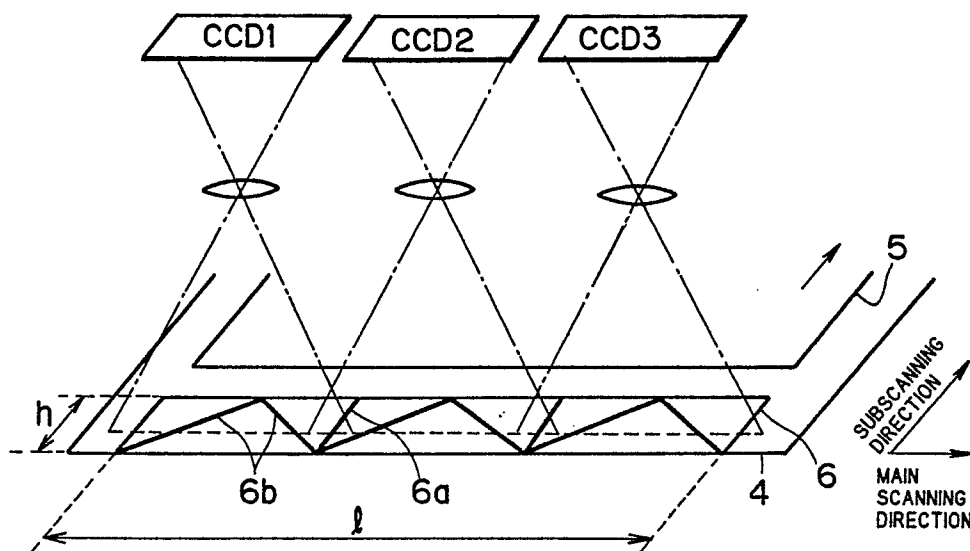
(72) Inventor: **Mitsuki, Kiyoomi Dainippon Screen**
Mfg. Co., Ltd
1-1, Tenjinkitamachi Teranouchi-Agaru
4-chome
Horikawa Dori Kamikyo-ku Kyoto(JP)

(74) Representative: **Goddard, Heinz J., Dr. et al**
FORRESTER & BOEHMERT
Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) **Method of and apparatus for connecting output image signals from a plurality of line image sensors.**

(57) An amount of a read position error in the subscanning direction between line image sensors (CCD1, CCD2, CCD3) is obtained by scanning and reading a correction read pattern (6a, 6b). In scanning of an original, output image signals from the line image sensors (CCD1, CCD2, CCD3) are relatively delayed by a line number corresponding to the amount of the read position error between the line image sensors (CCD1, CCD2, CCD3), to correct time difference, caused by the read position error, in information reading in the boundary portion of the line image sensors.

FIG. 2



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Method of and Apparatus for Connecting Output Image Signals from a Plurality of Line Image Sensors

BACKGROUND OF THE INVENTION

Field of the Invention

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The present invention relates to a method of and an apparatus for connecting output image signals from a plurality of line image sensors, which are arrayed in the main scanning direction for scanning an original and obtaining image information, by correcting an error in read positions of the line image sensors.

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Description of the Prior Art

In the case where a large screen must be read in high resolution for reading a design drawing or a map, or in the case where an original must be read in extremely high resolution in the field of electronic process printing for commercial printing, a plurality of line image sensors are generally arrayed in the main scanning direction to divide the screen along the main scanning direction to read the screen in a large pixel number. In this case, the respective line image sensors must read image information on the same main scanning line as a matter of course, whereas it is difficult to strictly situate the plurality of line image sensors to correctly perform reading on the absolutely same main scanning line. Even if complete positioning is performed in manufacturing, it is substantially impossible to maintain mechanical accuracy against vibration of transportation, time change, temperature change etc.

Since the respective image sensors are generally arrayed so that read positions on a scanning plane partially overlap with each other in boundary portions, an error in read positions along the main scanning direction can be absorbed to some extent, and hence no significant problem is caused. However, if such an error in read positions is caused in the subscanning direction, a read image may be interrupted in the case of reading thin lines extending in the main scanning direction in connecting portions of the respective line image sensors, whereby the image is indented in the subscanning direction to degrade the picture quality.

30 SUMMARY OF THE INVENTION

The present invention is directed to a method of and an apparatus for connecting output image signals from a plurality of line image sensors, which are arrayed in the main scanning direction for scanning an original and obtaining image information, by correcting an error in read positions of the respective line image sensors.

According to the present invention, read pattern for correction at least having a first pattern uniquely deciding a subscanning coordinate with respect to a main scanning coordinate on a scanning plane and intersecting with each portion, corresponding to each line image sensor, on one scanning line in at least two points is previously prepared, and an amount of the read position error in the subscanning direction between the plurality of image sensors are previously obtained from read pixel addresses of the respective line image sensors in scanning/reading of the first pattern by the respective line image sensors. Then, in scanning of the original, the output image signals from the respective line image sensors are relatively delayed between the line image sensors by a line number corresponding to the obtained amount of the read position error in the subscanning direction, to connect the output image signals.

Namely, according to the present invention, the read pattern for correction is scanned and read to obtain the amount of the read position error between the respective line image sensors in the subscanning direction, and, in scanning of an original, the output image signals from the respective line image sensors are relatively delayed between the line image sensors by a line number corresponding to the amount of the read position error, to correct time difference, caused by the read position error, in information reading in the boundary portion of the line image sensors.

Accordingly, an object of the present invention is to solve the aforementioned problem of the prior art and provide a method of and an apparatus for connecting output image signals of a plurality of line image signals, which can easily correct an error in read positions, particularly in the subscanning direction, with simple structure, in scanning an original by the plurality of line image sensors arrayed in the main scanning direction for obtaining image information, so that degradation in picture quality of a read image is effectively

prevented.

These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- Fig. 1 is a block diagram showing an embodiment of the present invention;
 Fig. 2 is an explanatory diagram showing array of CCD's and a correction reference chart;
 Fig. 3 is an explanatory diagram showing positional relation between the CCD's on the correction reference chart;
 Fig. 4 is an explanatory diagram showing pixels of the CCD's reading the correction reference chart;
 Fig. 5 is a flow chart showing the procedure of processing for operating amounts of a read position error in the subscanning direction;
 Fig. 6 is an explanatory diagram showing the status of writing in image memories;
 Fig. 7 is an explanatory diagram showing connection processing in the subscanning direction;
 Fig. 8 is an explanatory diagram of a correction range;
 Fig. 9 is a block diagram showing a circuit for correcting irregularity of an image caused by angle deviation;
 Fig. 10 is a block diagram showing a circuit for correcting irregularity in an image caused by angle deviation including connection processing in the main scanning direction; and
 Fig. 11 is an explanatory diagram for the operation of the circuit shown in Fig. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENT

- Fig. 1 is a block diagram showing an embodiment of an apparatus for connecting output image signals from line image sensors, according to the present invention. Referring to Fig. 1, three line image sensors (hereinafter referred to a CCD 1 to CCD 3) are shown. They are so arrayed in the main scanning direction that read positions on a scanning plane 4 partially overlap with each other in adjacent regions, as shown in Fig. 2. The scanning plane 4 is provided thereon with an original set table 5 and a correction reference chart 6 formed by read patterns 6a and 6b for correction for use in operation of connecting output signals from the CCD 1 to CCD 3 with respect to main and subscanning directions respectively.
- Fig. 3 illustrates positional relation between the CCD 1 to CCD 3 in correspondence to the correction reference chart 6. The CCD's 1 to 3 are subjected to a location error in the subscanning direction and angle deviation, as shown in the figure. Signals from the CCD 1 to CCD 3 reading the correction reference chart 6 are written in a position error detecting memory 8 enabled by a CPU 9, along addresses indicated by an address counter 7 synchronized with write clocks CK1. The CPU 9 performs connection processing in the main scanning direction and operates amounts ΔY_1 and ΔY_2 of correction for position error in the subscanning direction on the basis of the data in the memory 8. While such processing is hereinafter described in detail, count values being in correspondence to line numbers corresponding to the amounts ΔY_1 and ΔY_2 of correction for position error in the subscanning direction are loaded in address counters 10 to 12. In scanning of an original, read signals of the CCD's 1 to 3 are written in image memories 13 to 15, respectively, along addresses directed by the address counters 10 to 12 synchronized with the write clocks CK1. Thus, time difference in information reading in boundary portions of the CCD's 1 to 3, caused by the location error of the CCD's 1 to 3 in the subscanning direction, is corrected. Then, image signals are sequentially read from the image memories 13 to 15 along addresses directed by an address counter 16 synchronized with read clocks CK2, to obtain completely connected image signals which are equivalent to those obtained by scanning through the CCD 1, CCD 2' and CCD 3' (dashed ones show those whose location error in the subscanning direction is completely corrected).

With reference to Fig. 3, the connection processing in the main scanning direction and the processing for operating the amounts ΔY_1 and ΔY_2 of correction for the position error in the subscanning direction will be described.

- First, connection processing in the main scanning direction is performed by making an address of a pixel of the CCD 1 reading a point P_1 identical to an address of a pixel of the CCD 2 reading a point P_2 , while making an address of a pixel of the CCD 2 reading a point P_3 identical to an address of a pixel of the CCD 3 reading a point P_4 by employing the correction read pattern 6a extending in the subscanning

direction. If there are a plurality of pixels a_1 to a_n in the CCD 1 actually reading the point P_1 , as shown in Fig. 4, for example, the central pixel a_5 is treated as a read pixel for the point P_1 . Slanting lines in Fig. 4 express black levels of bilevel data.

Fig. 5 is a flow chart showing the procedure of processing of the CPU 9 at the time of operating the amounts Y_1 and Y_2 of correction for the position error in the subscanning direction. At a step S1, signals from the CCD 1 to CCD 3 reading the correction reference chart 6 are stored in the position error detecting memory 8, as hereinabove described. At a step S2, the CPU 9 detects pixels of the CCD's 1 to 3 reading the correction read pattern 6b, i.e., pixels of black levels corresponding to points P_5 to P_{10} . At a subsequent step S3, the CPU 9 defines respective single read pixel addresses x_1 to x_6 in a similar manner to that shown in Fig. 4.

At a step S4, the CPU 9 calculates amounts ΔY_1 and ΔY_2 of correction in the subscanning direction by employing the pixel addresses x_1 to x_6 by the following expressions:

$$\Delta Y_1 = \frac{2h}{A} \cdot \left\{ \frac{(A - x_2 - x_1)(A - x_1)}{x_2 - x_1} - \frac{(3A - x_4 - x_3)(A - x_3)}{x_4 - x_3} + (A + x_1 - x_3) \right\} \dots (1)$$

$$\Delta Y_2 = \frac{2h}{A} \cdot \left\{ \frac{(A - x_2 - x_1)(A - x_1)}{x_2 - x_1} + \frac{(3A - x_4 - x_3)(A - x_3)}{x_4 - x_3} - \frac{(5A - x_6 - x_5)(2A - x_5)}{x_6 - x_5} + (2A + x_1 - x_5) \right\} \dots (2)$$

where A represents effective pixel number of the respective CCD's 1 to 3, l represents effective length in the main scanning direction and h represents the width of the correction reference chart 6.

The process of deriving the above expression (1) is as follows: Considering an XY-coordinate system by length with an origin O in Fig. 3, x_1 and x_2 denoting pixel addresses are converted into lengths in the direction X from the origin O to obtain X_5 and X_6 of the points P_5 and P_6 . Since the main scanning direction effective length is l and the effective pixel number corresponding thereto is $3A$, X -coordinates of the points P_5 and P_6 are as follows:

$$X_5 = (l/3A) \cdot x_1 \quad (3)$$

$$X_6 = (l/3A) \cdot x_2 \quad (4)$$

The correction read pattern 6b is a pattern in which subscanning coordinates (Y -coordinates) are uniquely decided with respect to main scanning coordinates (X -coordinates), and hence the Y -coordinates can be defined upon definition of the X -coordinates. The correction read pattern 6b is a regular pattern repeatedly bent per $l/6$ within the width h as shown in the figure, and Y -coordinates Y_5 and Y_6 corresponding to the above X_5 and X_6 can be decided as follows:

$$Y_5 = 2hx_1 / A \quad (5)$$

$$Y_6 = 2h(A - x_2) / A \quad (6)$$

Similarly, X -coordinates X_7 and X_8 and Y -coordinates Y_7 and Y_8 of points P_7 and P_8 are decided as follows:

$$X_7 = (l/3A) \cdot x_3 \quad (7)$$

$$X_8 = (l/3A) \cdot x_4 \quad (8)$$

$$Y_7 = 2h(x_3 - A) / A \quad (9)$$

$$Y_8 = 2h(2A - x_4) / A \quad (10)$$

An expression of a straight line passing through the two points P_5 and P_6 is as follows:

$$Y = \frac{Y_6 - Y_5}{X_6 - X_5} (X - X_5) + Y_5 \quad \dots (11)$$

The value $X = l/3$ is substituted in the expression (11) to find the Y-coordinate Y_1 of the point P_1 :

$$Y_1 = \frac{Y_6 - Y_5}{X_6 - X_5} \left(\frac{l}{3} - X_5 \right) + Y_5 \quad \dots (12)$$

The Y-coordinate Y_2 of the point P_2 is similarly found as follows:

$$Y_2 = \frac{Y_8 - Y_7}{X_8 - X_7} \left(\frac{l}{3} - X_7 \right) + Y_7 \quad \dots (13)$$

The correction amount Y_1 is expressed as follows:

$$\Delta Y_1 = Y_1 - Y_2 \quad (14)$$

The expressions (12) and (13) are substituted in the expression (14) and the expressions (3) to (10) are further employed, to obtain the above expression (1). The expression (2) for calculating a correction amount ΔY_2 can also be derived in a similar manner to the above.

At a step S5 in Fig. 5, the correction amounts ΔY_1 and ΔY_2 found at the step S4 are divided by a scanning line pitch p on the scanning plane 4 to convert the same into line numbers, to find correction line numbers $\Delta LINE_1$ and $\Delta LINE_2$ corresponding to the correction amounts ΔY_1 and ΔY_2 . The remainder of division by p may be raised to a unit if it exceed $p/2$, while being omitted if it is less than $p/2$.

At a subsequent step S6, the CPU 9 loads address count values corresponding to the correction line numbers $\Delta LINE_1$ and $\Delta LINE_2$ in the address counters 10 to 12. Assuming that one address corresponds to image data for one pixel in the image memories 13 to 15 for the purpose of simplification, respective load values in the address counters 10 to 12 are as follows:

address counter 10 ... 0
address counter 11 ... $A \times \Delta LINE_1$
address counter 12 ... $A \times \Delta LINE_2$

where A represents the effective pixel number of the respective CCD's 1 to 3, as hereinabove described. The load value in the address counter 10 may not be 0, if the load values of the address counters 11 and 12 relatively hold difference of $A \times \Delta LINE_1$ and $A \times \Delta LINE_2$ with respect to the load value of the address counter 10, respectively.

In scanning of an original (not shown) set on the original set table 5 shown in Fig. 2, the signals from the respective CCD's 1 to 3 are written in the respective image memories 13 to 15 enabled by the CPU 9, along addresses directed by the address counters 10 to 12 synchronized with the write clock CK1. Fig. 6 illustrates the status of writing in the image memories 13 to 15 in the case where the load values of the address counters 10 to 12 are "0", "-2A" and "-5A", respectively, i.e. in the case where $\Delta LINE_1$ corresponding to the correction amount ΔY_1 in Fig. 3 is -2 lines and $\Delta LINE_2$ corresponding to ΔY_2 is -5 lines. In this case, a signal read by the CCD 2 is obtained in delay by two lines from a read signal by the CCD 1 for the same point in a connecting portion between the CCD 1 and CCD 2, and hence a third line read signal of the CCD 2 may follow a first line read signal of the CCD 1, in order to corrected the read position error. Further, a read signal by the CCD 3 is obtained in delay by three lines from a read signal by the CCD 2 for the same point in a connecting portion between the CCD 2 and CCD 3, and hence a fourth line read signal of the CCD 3 may follow a first line read signal of the CCD 2, in order to correct the read position error. The load values "0", "-2A" and "-5A" of the address counters 10 to 12 are employed to perform such operation. Thus, connection processing along the subscanning direction is performed on the image memories 13 to 15 in response to the load values, as shown in Fig. 6.

In reading, the CPU 9 loads the address of an image signal to be read first in the address counter 16. Then, image signals are sequentially read from the image memories 13 to 15 along addresses directed by

the address counter 16 synchronized with the read clocks CK2. For example, a first line read signal of the CCD 1, then a third line read signal of the CCD 2 and then a sixth line read signal of the CCD 3 are read in sequence, in response to count values 1 to 3A of the address counter 16.

Fig. 7 is an explanatory diagram of the result of the aforementioned connection processing in the subscanning direction. Fig. 7(a) illustrates positional relation between the CCD's 1 to 3 similarly to Fig. 3. Assuming that an original consisting of a straight line L shown in Fig. 7(b), which is parallel to the main scanning direction, is scanned by the CCD's 1 to 3. Image signals are interrupted in connecting portions as shown in Fig. 7(c), if no connection processing is performed in the subscanning direction. On the other hand, image signals with no interruption are obtained, as shown in Fig. 7(d), by performing the aforementioned connection processing in the subscanning direction to correct location errors in the connecting portions. Thus, the picture quality is improved.

When the correction amounts ΔY_1 and ΔY_2 are converted into the correction line numbers ΔLINE_1 and ΔLINE_2 , the remainder of division by the scanning line pitch p is raised to a unit or omitted depending on whether it is in excess of or less than $p/2$ as hereinabove described, and hence errors of $\pm 1/2$ line at the maximum are caused in the connecting portions. Although such errors are substantially inconspicuous, the picture quality can be further improved by employing a weighted mean system of gradually mixing image signals of respective pixels in prescribed connecting blocks in a proportional distribution manner, as hereinafter described in detail with reference to Fig. 10.

The image shown in Fig. 7(d), thus obtained, is substantially recognized as a straight line, since l is several 10 cm, whereas ΔY is several 10 μm to several 100 μm at the utmost in practice. However, the image signals after connection processing may be further processed by a circuit shown in Fig. 9, in order to obtain a better image by correcting irregularity in the image caused by angle deviation of the CCD's 1 to 3. Referring to Fig. 9, image signals after connection processing are supplied to a group 17 of a plurality of serially connected line memories, so that an output signal from any of the line memories or an image signal not passing through the line memories is switched by a selector 18 and outputted. A switching signal S, the content of which is shown in Fig. 7(e), is supplied by the CPU 9. The selector 18 outputs image signals I_1 to I_6 in response to numbers 1 to 6 in Fig. 7(e), respectively. Timing for switching of the switching signal S can be recognized by dividing the effective pixel number A of the CCD's 1 to 3 by angle deviation line number n (line number corresponding to K in Fig. 8 as hereinafter described) of each of the CCD's 1 to 3. Namely, the image signals are relatively delayed sequentially by one line per A/n pixels. Obtained as the result is a straight line shown in Fig. 7(f), which is identical to the original. Such processing may be performed after the aforementioned connection processing, to extremely reduce the memory capacity to be prepared for the line memory group 17.

Now, the degree of correctable angle deviation will be examined. Assuming that a CCD has effective bits of 4500, such effective bits of 4500 must be maintained, however inclined the CCD is. Referring to Fig. 8, the CCD is inclined to require 4501 bits for the same scanning point on an original when

$$K = \sqrt{4501^2 - 4500^2} \approx 94 \text{ (pixels)}$$

and hence mechanical assembling accuracy for the CCD must be within 658 μm , assuming that one pixel is 7 μm . The accuracy is preferably not more than 329 μm ($x = 47$), the half in the above, in view of quantization errors. Namely, even though the CCD is erroneously obliquely located, correction can be relatively effectively performed if such location error is within 47 lines.

Fig. 10 illustrates another embodiment of connection processing in the main scanning direction. Fig. 11 illustrates timing thereof. Fig. 11(a) and Fig. 11(b) are identical to Fig. 7(a) and Fig. 7(b). The following connecting methods are well known in the art:

(a) a method of subjecting one array output to voltage control amplification gradually changed from a constant value while subjecting the other array output to voltage control amplification gradually changed from zero to a constant value, in an overlappingly read connecting area, to add up respective amplification outputs, to thereby connect picture information between respective image pickup element arrays;

(b) a method of generating random numbers in a connecting area to switch signals of respective image pickup elements in response to the generated random numbers;

(c) a method of detecting pixels having small density change in a connecting area, to switch respective image pickup elements;

(d) a method of most simply switching respective image pickup elements in a predetermined position in an overlapping area to perform connection processing, as described with reference to Fig. 3 and Fig. 7.

Any of such connecting methods is performed in a connection processing circuit 27.

In this embodiment, all pixel data of the CCD's 1 to 3 are stored in the image memories 13 to 15 shown in Fig. 1 and Fig. 6. Overlapping parts are present in the image data, as shown by slanting lines in Fig. 11(c) and Fig. 11(d). Writing in the image memories 13 to 15 is performed in timing as shown in Fig. 11(c),

and reading is performed in such timing that image data are necessarily present in portions of 1, as shown in Fig. 11(d), to output the image data to line memory units 20, 21 and 22 shown in Fig. 10.

In the line memory units 20 to 22, switching is performed by an electronic switch 24 at timing of Figs. 11(e), 11(f) and 11(g) by outputs S_1 to S_3 of a timing controller 26, to output signals after switching to the connection processing circuit 27.

The connection processing circuit 27 performs any processing of the aforementioned items (a) to (d) in areas shown by slanting lines in Fig. 11(i). Fig. 11(h) illustrates an example of performing the simplest switching connection processing in a constant position. The connection processing circuit 27 outputs an image signal shown in Fig. 11(j).

An advantage of this embodiment is that various switching means (connection processing) are enabled while only the simplest switching in a constant position can be performed in the embodiment illustrated in Fig. 9.

Further, although the memories 13 to 15 require capacity larger than the pixel numbers of the CCD's 1 to 3, respectively, (however, since capacity for a memory is generally 2^n and an effective pixel signal number of a CCD is in conformity to 2^n as a rule, the memories 13 to 15 are not superfluously increased in capacity for the most part) in the embodiment illustrated in Fig. 1, the embodiment illustrated in Fig. 10 has such advantages that line memories 23a to 23d shown in Fig. 10 may be reduced in capacity to about 1/3 of a single line memory shown in Fig. 9; and the number of the line memories 23a to 23d may be smaller by one than that of the line memories shown in Fig. 9 as obvious from comparison of Figs. 7(d) and 11(d), and in general, the number of the line memories 23a to 23d may be within the number K described with reference to Fig. 8, although the line memories shown in Fig. 9 must be provided in a number three times K.

In consideration similar to that described with reference to Figs. 2 to 5 in relation to the embodiment illustrated in Fig. 1, timing for writing in the memories 13 to 15, read timing and timing for writing in reading from memory units 20 to 22 shown in Fig. 11 are obtained by the position error detecting memory 8 and the CPU 9 shown in Fig. 1.

While P_1 to P_n shown in Fig. 3 are obtained from bilevel signals, in Fig. 4, values of a_1 to a_n shown in Fig. 4 have levels if CCD outputs are extracted as signals having gradation, and more precise positional information can be read by judging the levels, to improve accuracy of the connecting positions.

Although the correction read patterns 6a and 6b of the correction reference chart 6 are formed by lines in the aforementioned embodiment, the same may be formed to detect boundary portions thereof by separate coating of different colors.

There is a well known method of projecting an original image to a plurality of line image sensors, which are intentionally deviated by a plurality of scanning lines in the subscanning direction in an offset manner, by utilizing a single lens to store signals from a sensor performing earlier scanning by the deviated scanning lines in a memory to time the same with signals from a sensor performing later scanning. It is obvious that the present invention is also applicable to such a method.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

The features disclosed in the foregoing description, in the claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. A method of connecting output image signals from a plurality of line image sensors, which are arrayed in a main scanning direction for scanning an original to obtain image information, by correcting an error in read positions of the line image sensors, which method comprises: providing a correction read pattern having at least a first pattern uniquely defining a subscanning coordinate with respect to a main scanning coordinate in a scanning plane and having at least two points of intersection with each portion of a main scanning line corresponding to a line image sensor; scanning the first pattern and determining the amount of a read position error in a subscanning direction between the line image sensors from read pixel addresses of the line image sensors; scanning the original and connecting the output image signals from the line image sensors by relatively delaying the output image signals by a number of scanning lines corresponding to the determined amount of the read position error in the subscanning direction between the line image sensors.

2. A method according to claim 1, further comprising: determining the amount of angular deviation of each of the plurality of line image sensors from read pixel addresses of the line image sensors upon scanning the first pattern as a number (n) of scanning lines; and correcting for the angular deviation upon scanning the original by relatively delaying the output image signals from the line image sensors sequentially by one lines per A/n pixels (where A represents the effective number of pixels of each line image sensor).

3. A method according to claim 2, wherein the correcting of the angular deviation comprises the steps of: producing image signals obtained by delaying said output image signals of the line image sensors by 0 to n lines; and selecting the produced image signals every A/n pixels.

4. A method according to any one of claims 1 to 3, wherein the plurality of line image sensors are arrayed partially to overlap with each other in an adjacent region and the correction read pattern has a second pattern extending in the subscanning direction, which method comprises connecting pixels of adjacent line image sensors in the main scanning direction upon scanning the second pattern by making corresponding pixel addresses of the adjacent line image sensors identical to each other.

5. A method according to claim 4, wherein the first and second patterns are formed by a thin line.

6. An apparatus for connecting output image signals from a plurality of line image sensors (CCD1, CCD2, CCD3), which are arrayed in the main scanning direction for scanning an original to obtain image information, by correcting an error in read positions of the line image sensors, which apparatus comprises: a correction read pattern (6) having at least a first pattern (6b) uniquely defining a subscanning coordinate with respect to a main scanning coordinate in a scanning plane and having at least two points of intersection with each portion of a main scanning line corresponding to a line image sensors; means (7, 8, 9) for determining the amount of a read position error in a subscanning direction between the line image sensors from read pixel addresses of the line image sensors upon scanning of the first pattern by the line image sensors; and means (10-16) for connecting the output image signals obtained from the line image sensors upon scanning the original by relatively delaying the output image signals by a number of scanning lines corresponding to the determined amount of the read position error in the subscanning direction between the line image sensors.

7. An apparatus according to claim 6, further comprising: means for determining the amount of angular deviation of each of the plurality of line image sensors from read pixel addresses of the line image sensors upon scanning of the first pattern by the line image sensors as a number (n) scanning lines; and means for correcting the angular deviation upon scanning the original by relatively delaying the output image signals from the line image sensors sequentially by one line per A/n pixels (where A represents the effective number of pixels of each line image sensor).

8. An apparatus according to claim 7, wherein the means for performing correction of the angular deviation comprises: means (17) for producing image signals obtained by delaying said output image signals of the line image sensors by 0 to n lines; and means (9, 18) for selecting the produced image signals every A/n pixels.

9. An apparatus according to any one of claims 6 to 8, wherein the plurality of line image sensors are arrayed partially to overlap with each other in an adjacent region and the correction read pattern has a second pattern (6a) extending in the subscanning direction, which apparatus comprises means (9) for connecting pixels of adjacent line image sensors in the main scanning direction upon scanning the second pattern by making corresponding pixel addresses identical to each other.

10. An apparatus according to claim 9, wherein the first and second patterns are formed by a thin line.

11. An apparatus according to any one of claims 6 to 9, wherein the means for connecting the output image signals from the line image sensors comprises: storage means (13-15) for storing the output image signals and means (10-12, 16) for addressing write and read addresses of the storage means so that the output image signals read from the storage means are relatively delayed between the line image sensors by a number of scanning lines corresponding to the amount of the read position error in the subscanning direction.

FIG. 1

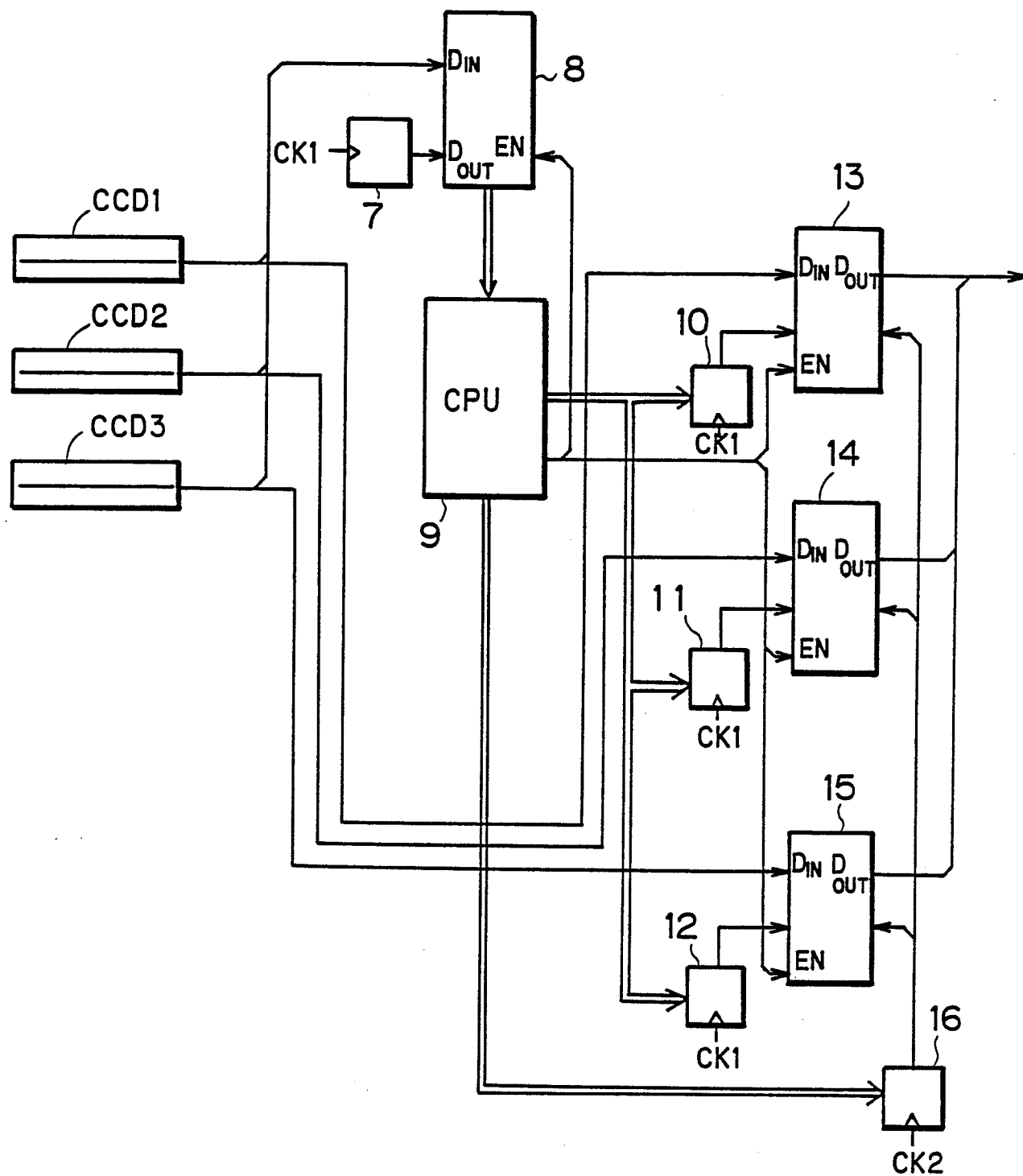


FIG. 2

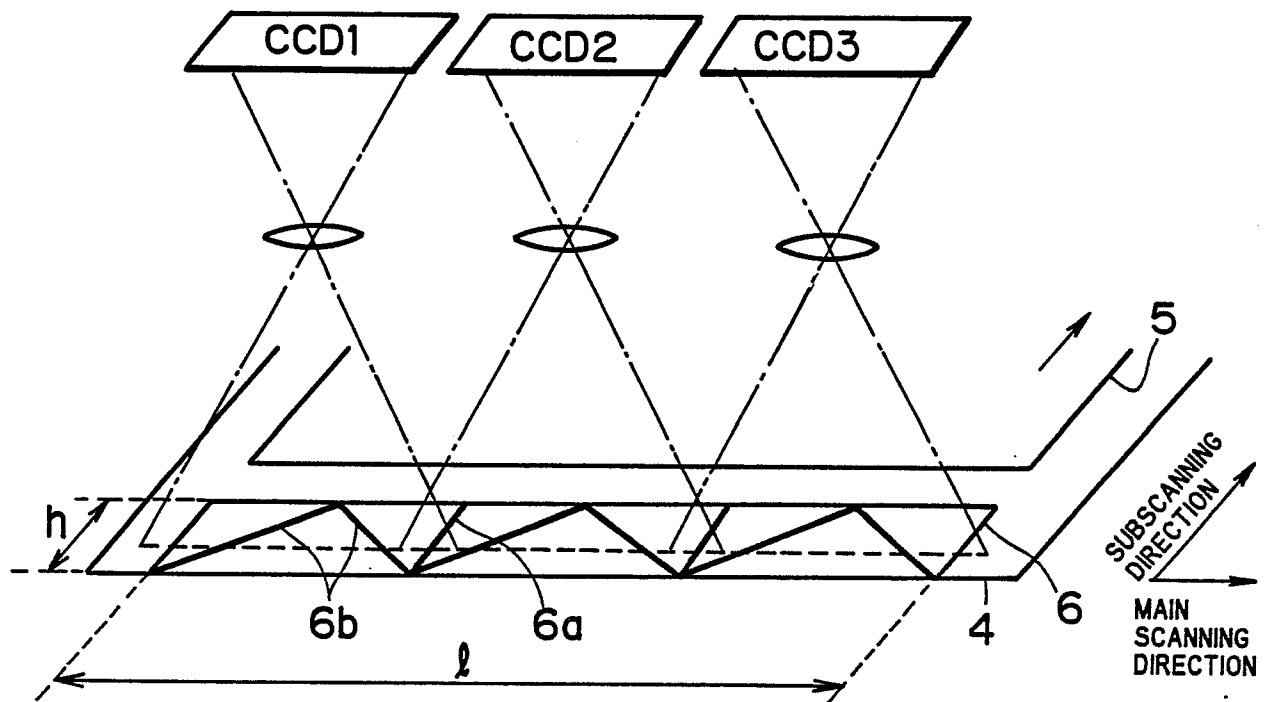


FIG. 5

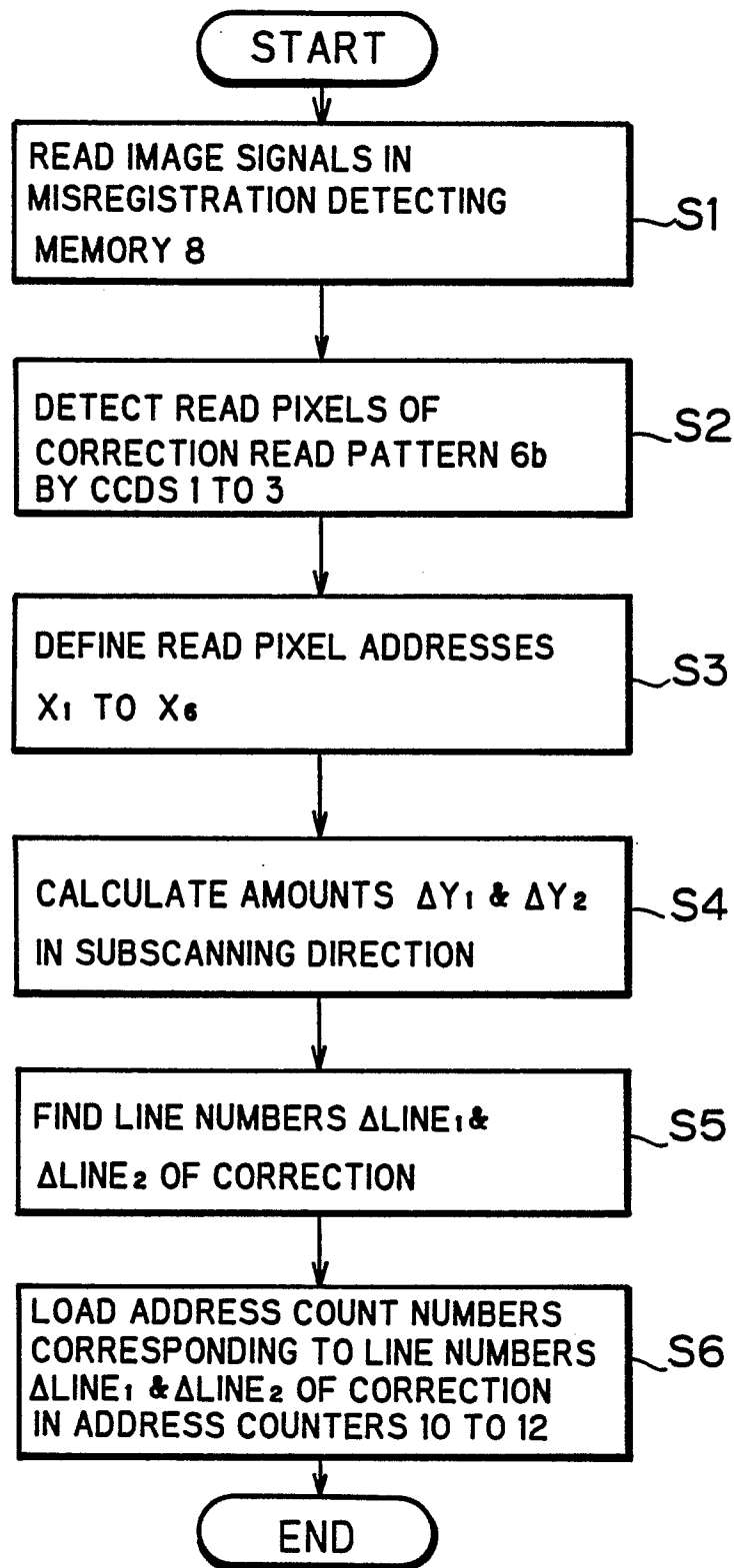


FIG. 7(a)

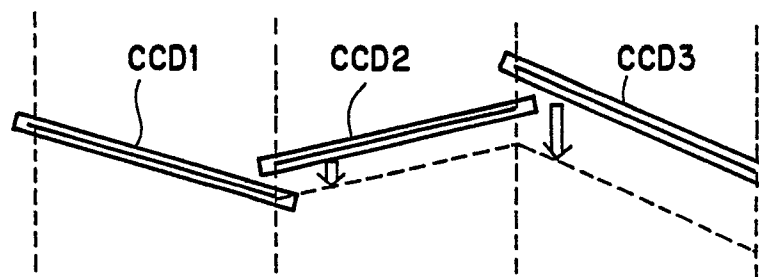


FIG. 7(b)

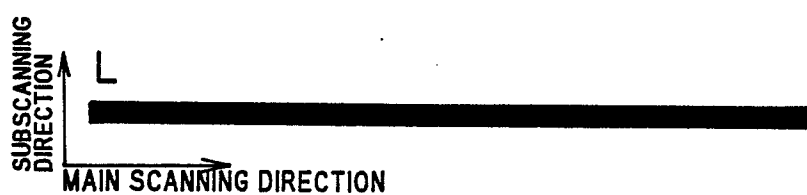


FIG. 7(c)

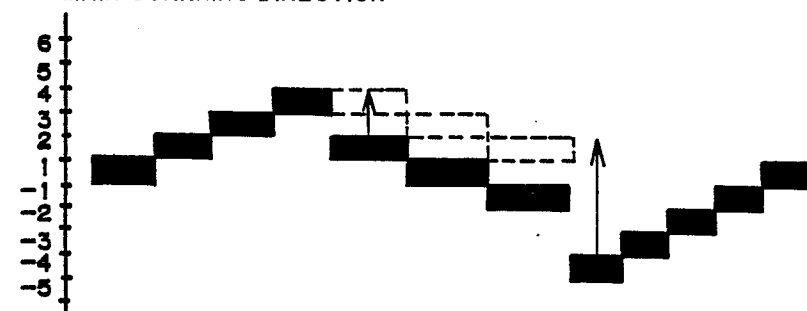


FIG. 7(d)

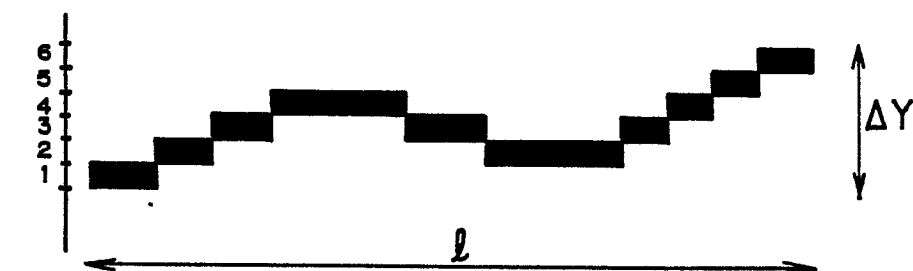


FIG. 7(e)



FIG. 7(f)



FIG. 8

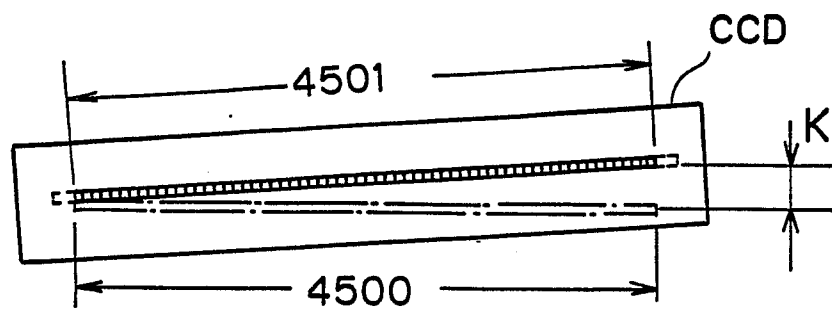


FIG. 9

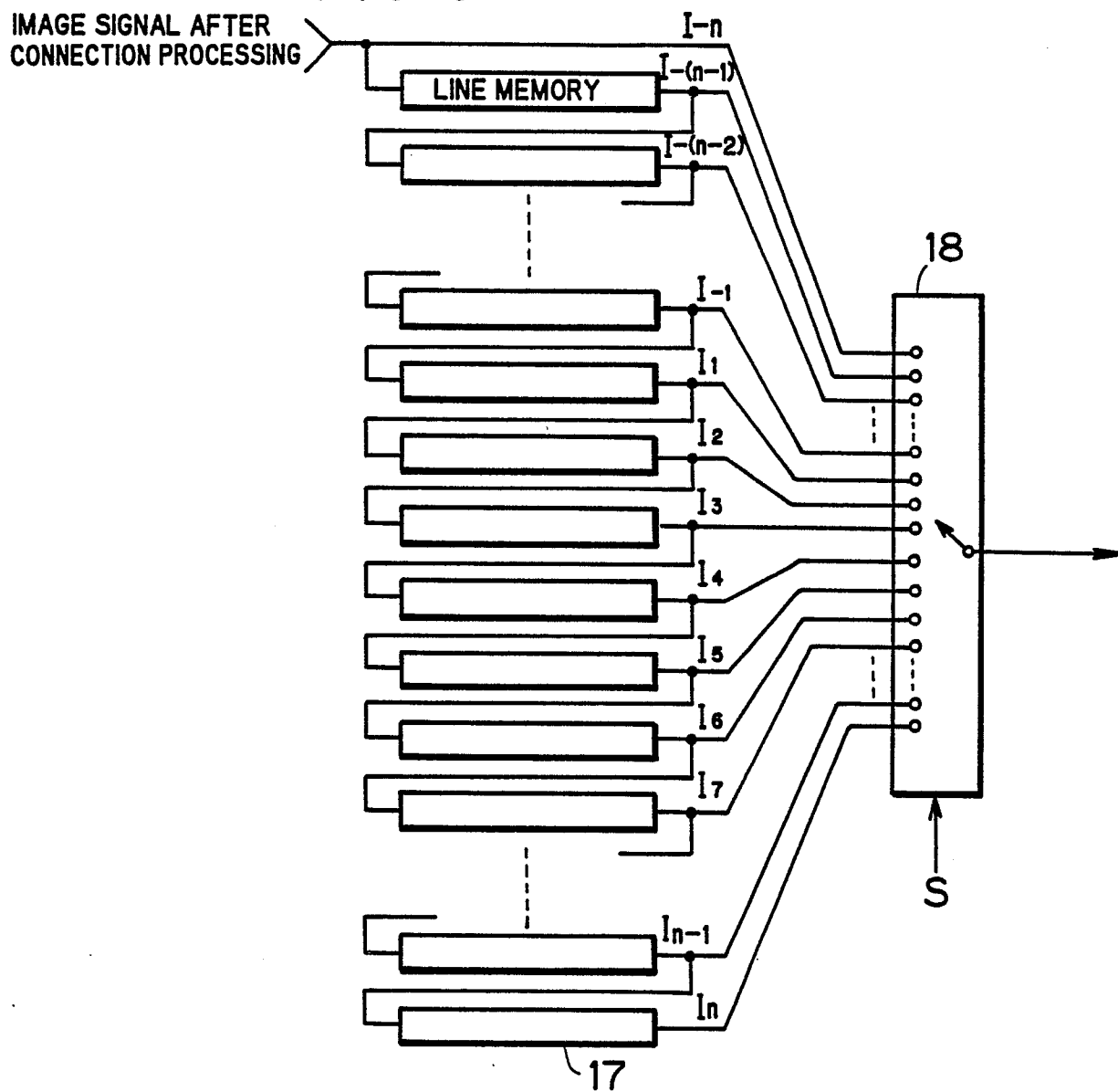


FIG. 10

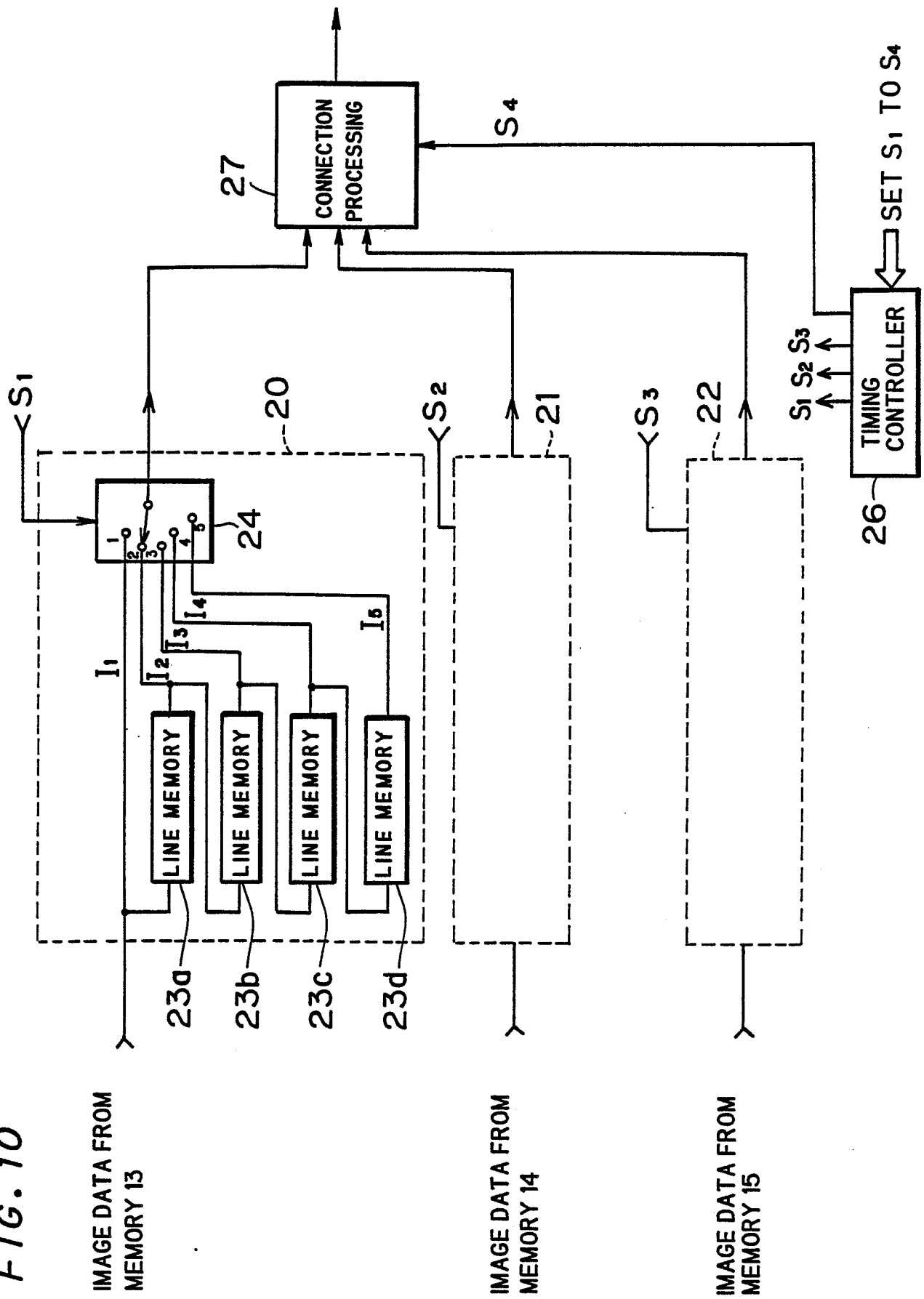


FIG. 11(a)

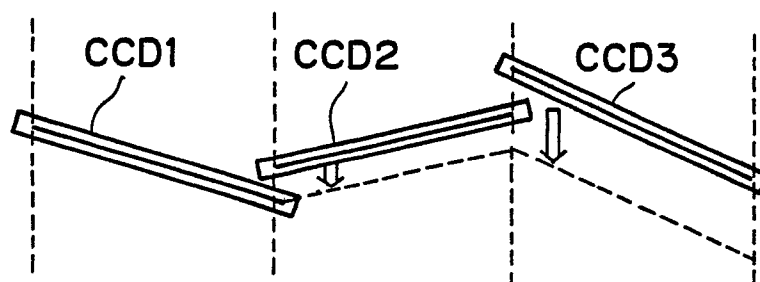


FIG. 11(b)

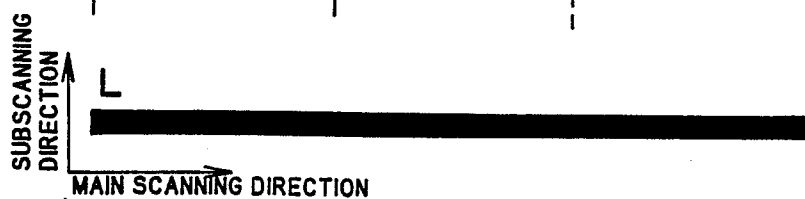


FIG. 11(c)

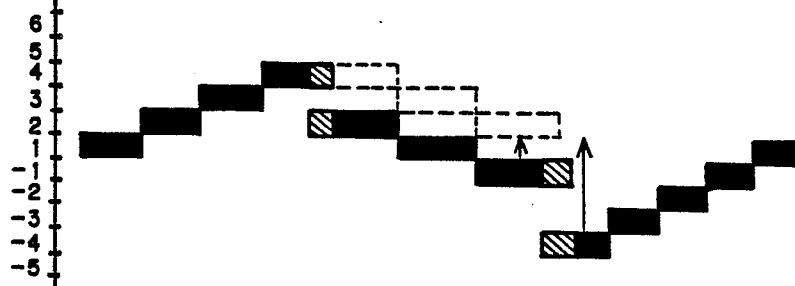


FIG. 11(d)

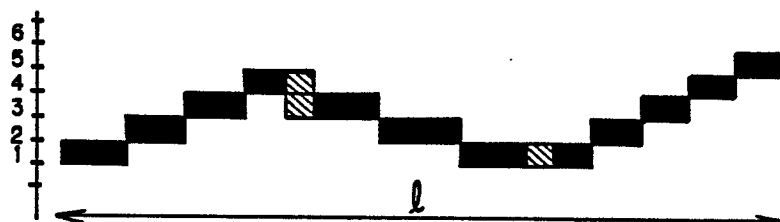


FIG. 11(e)



FIG. 11(f)

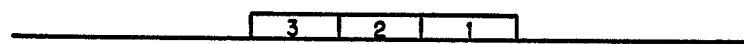


FIG. 11(g)



FIG. 11(h)

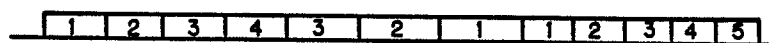


FIG. 11(i)



FIG. 11(j)

